Data Collection Activity - Walk This Way

I. The Position Function

1. Using your data from the experiment, make a distance (position) vs. time scatterplot on your calculator. What type of function best fits the data? ______________________ Do a **regression analysis** of the data and find a function that fits the data well. Round all values to the nearest 0.01.

The equation of your regression curve, which gives the position **s** of the walker vs. time **t** is:

s(t) = ____

Put this function in **Y1**, graph it, and then turn off the Scatterplot.

2. Over what interval(s) is the walker getting **closer** to the CBR? ______________________________

3. Over what interval(s) is the walker getting **farther** from the CBR? ___________________________

4. Make a guess as to what is happening to the **velocity** on the interval(s) where the walker is moving **closer** to the CBR. ______________________ And moving **farther** from the CBR? ________________

5. What do you think the **velocity** of the walker was at the instant he/she was **changing direction**? ______

6. At what **time(s)** does this occur? ________ What is the walker's **position** at this time? __________

7. What is the **average velocity (average rate of change)** of the walker from **t = 3** to **t = 5**? Show below how you calculated it. (Remember the units!)

8. To **approximate** the **instantaneous velocity** of the walker at **t=3**, find the **average rate of change** of s(t) from **t = 3** to **t = 3.01**. ______________

II. The Velocity Function

9. We also have the "velocity" data in L3 of our calculator. Set up and graph a scatterplot of the velocity vs. time data. This scatterplot shows the velocity of the walker at a specific time. (Deactivate the position function, but don't delete it!)

10. We could determine this function using the same procedure as we did for the distance vs. time data above, but we know calculus! What is the relationship between the position function and the velocity function?

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11. Determine the velocity function **v(t)** with calculus. **v(t)=** ______________________________
Put the function in Y2 and check your answer by graphing it with the scatterplot. If it doesn't fit the data, find your mistake!

12. Use the graph of the **velocity function** to find at what times the walker is **changing direction.** (Of course we could do this algebraically with the quadratic formula!) Compare this answer with the answer in Question 5.

13. On what intervals is the velocity function **positive?**____________ **negative?** ____________
(Have we seen these intervals before?)

14. Use your velocity function to determine the **instantaneous velocity** of the walker at **t=3.** _________
(How does this compare to our approximation in Question 8?)

III. The Acceleration Function

15. We also have the "acceleration" data in L4 of our calculator. Set up and graph a scatterplot of the acceleration vs. time data. This scatterplot shows the acceleration of the walker at a specific time.

16. Again, we can find a function that fits this data using calculus. How?

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17. Determine the acceleration function **a(t)** with calculus. **a(t)** = ____________________
Put the function in Y3 and check your answer by graphing it with the scatterplot. If it doesn't fit the data, find your mistake!

IV. Notation with the Position/Velocity/Acceleration Functions

Since the **velocity function is the derivative of the position function,** we can write:

$$v(t)=s'(t) \text{ or } v(t)=\frac{ds}{dt}.$$

Also, the **acceleration function is the derivative of the velocity function,** which means the **acceleration function is the second derivative of the position function,** and we can write:

$$a(t)=v'(t)=s''(t) \text{ or } a(t)=\frac{dv}{dt}=\frac{d}{dt}\left(\frac{ds}{dt}\right)=\frac{d^2s}{dt^2}$$

V. Comparing the Graphs of the Position, Velocity, and Acceleration Functions

Turn on the position function in Y1 and its derivative, the velocity function, in Y2. Here is an important relationship between the two graphs:

"The y-value of a point on the graph in Y2 is the slope of the tangent line of the corresponding point in Y1."

Since the acceleration function, in Y3, is the derivative of the velocity function, in Y2, the same relationship holds.

"The y-value of a point on the graph in Y3 is the slope of the tangent line of the corresponding point in Y2."

So, if you are given the graph of a function f, can you sketch the graph of its derivative function f'?